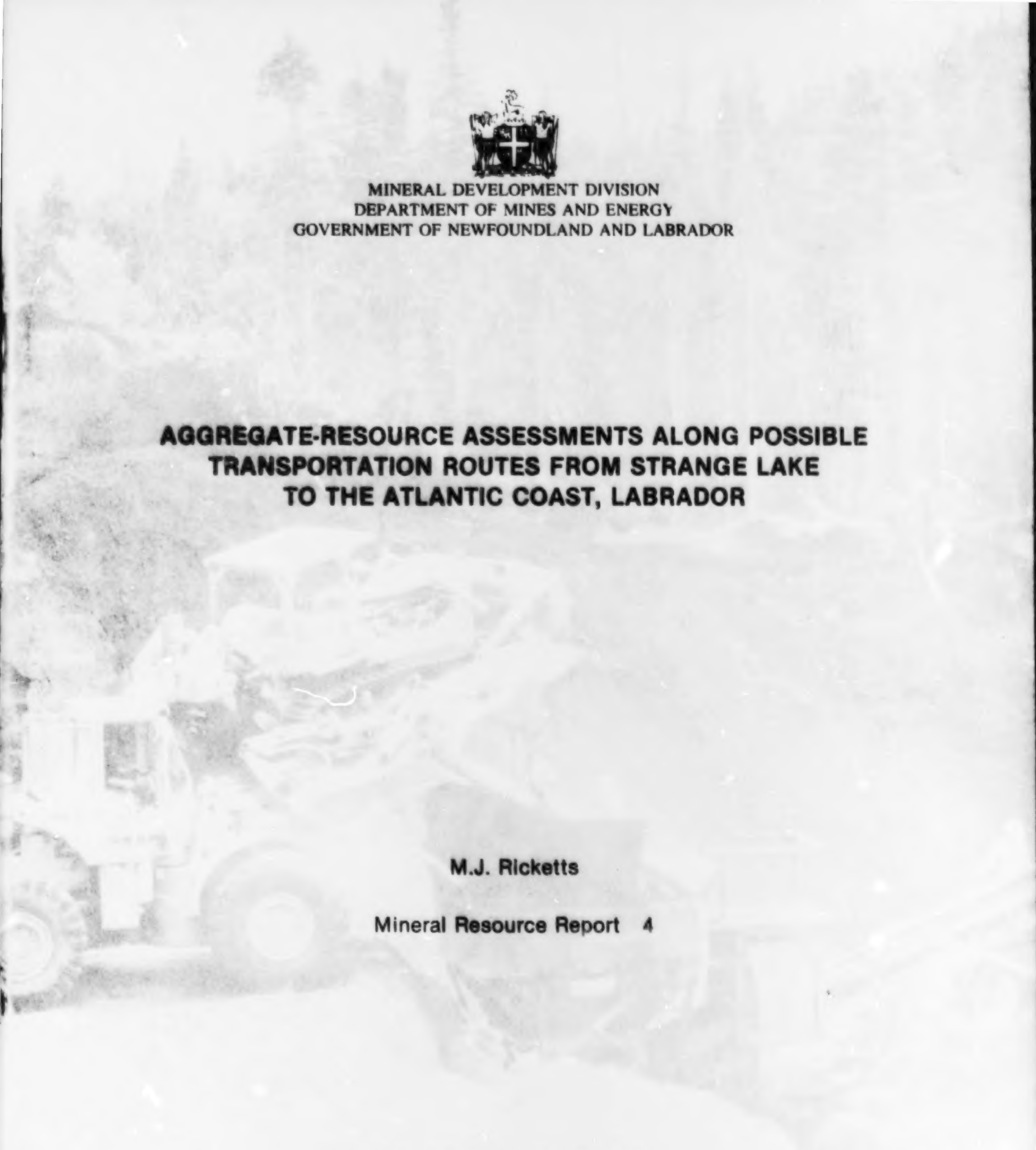

MINERAL DEVELOPMENT DIVISION
DEPARTMENT OF MINES AND ENERGY
GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

AGGREGATE-RESOURCE ASSESSMENTS ALONG POSSIBLE TRANSPORTATION ROUTES FROM STRANGE LAKE TO THE ATLANTIC COAST, LABRADOR

M.J. Ricketts

Mineral Resource Report 4

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ABSTRACT

An aggregate-resource inventory was conducted along a proposed transportation route across northern Labrador, from the Strange Lake mineral deposit to Anaktalak Bay and Voisey Bay, approximately 30 km south of Nain. The study was conducted as an aid to the possible construction of a road for transporting ore to the coast. The route selected follows the prevailing topography, has abundant coarse granular materials, and appears to be the cheapest to construct.

INTRODUCTION

Development of the Strange Lake mineral deposit (Figure 1) will require a transportation route to deliver the raw or partially refined ore to markets in Canada or elsewhere. This route could take either an eastward direction via the Ikadlivik valley to the Labrador coast, or a southwestward direction to Schefferville. There are several factors that will influence construction and give preference for an eastward route:

1) It is the shortest route; the southwestward route to Schefferville would cover a distance of approximately 240 km, approximately 100 km longer than the proposed eastward route. The distance along the southwestward route would be greatly increased by detouring around large lakes.

2) The eastward route follows the prevailing topography over a glaciofluvial outwash system that has abundant granular material essential to economic construction. A southwestward route would generally be transverse to the topogaphic grain. From analyses of topographic maps and reports, some areas along the southwestward route appear to be devoid of granular materials.

3) The eastward route to the coast has some areas where infilling and bridge construction may be required. However, these are few compared to a southwestward route where a number of large rivers, particularly the George River (Ives, 1960) and some of its many tributaries, may have to be crossed.

In summary, the southwestward route would be longer, transverse to topographic grain and vastly more difficult and costly to construct. Therefore, an aggregate-resource study along possible eastward routes to the Labrador coast was undertaken to describe the terrain and to provide data to encourage construction of an access route across Labrador.

Objectives

The main objective of the project was to determine the quantity and quality of aggregate material along proposed routes to the coast. Surficial maps derived from airphoto interpretation were used as a guide to delineate and sample areas of potential aggregates. The study involved the locating and detailed sampling of aggregate resources in the area. Water depths were estimated in areas where eskers have been dissected by streams or have terminated in lakes. Extensive stretches of bogland and rock outcrops along the route were also noted, as well as potentially unstable areas such as those with large deposits of clay and silt, areas of permafrost, and rock falls along narrow valley segments.

Previous Work

Hare (1959) completed a photo-reconnaissance survey of Labrador – Ungava; it determined drift cover and physiographic type as a secondary objective. A glacial study by Henderson (1959) was completed for central Quebec – Labrador. A report by Ives (1960) includes information on eskers and associated glacial drainage features in the westernmost portion of the study area.

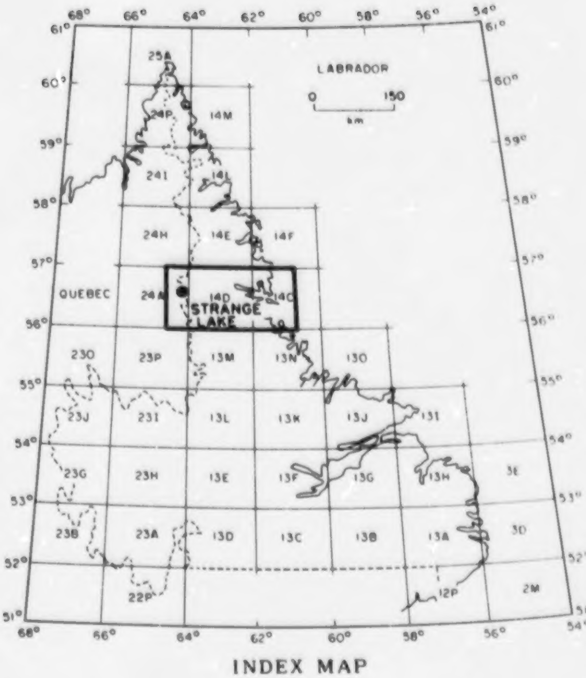

Figure 1. *Location of study area.*

Preliminary airphoto interpretation and landform classification maps (Figure 2) were completed by Batterson and Vanderveer (1984). This work included 1:50,000 scale maps for nearly all of the Tasisuak Lake map area (14D) and the Newfoundland section of the Lac Brisson map area (24A). This was followed by two weeks of reconnaissance Quaternary mapping by Vanderveer and Batterson in the vicinity of the Strange Lake deposit in July, 1983 (McConnell *et al.*, 1984). A preliminary study on Strange Lake transportation routes was conducted in 1984 (Batterson and Vanderveer, 1984). Detailed Quaternary mapping was completed in map areas 14D/5 and the Newfoundland section of 24A/8 (Batterson *et al.*, 1985).

Regional Setting

The Strange Lake mineral deposit is situated on the Quebec – Labrador border approximately 150 km west of Nain in a plateau region 500 m above sea level. Some major steep-sided valleys incise the plateau, up to 100 km inland from the eastern coast. The best known of these is the Fraser Valley west of Nain. These valleys trend east – west and are controlled by fracture zones which probably served as outlets for meltwater from retreating glaciers. The

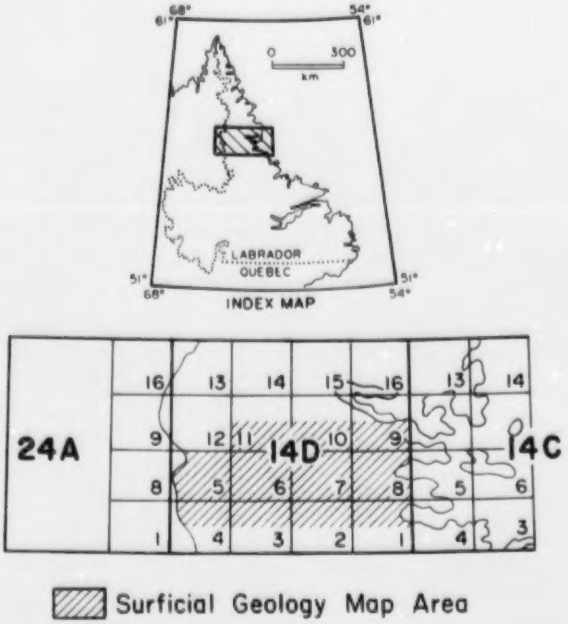

Figure 2. *Surficial-geology study area showing NTS map area.*

topography around Strange Lake is characterized by rolling hilly country that has approximately 20 percent bog cover. The plateau is a treeless landscape covered by a tundra vegetation, and lies within the zone of discontinuous permafrost. Numerous ponds and lakes cover much of the area. Quaternary deposits are composed predominantly of tills, including some crag and tail hills that are greater than 2 km long. Two glaciofluvial outwash systems commence near the Strange Lake deposit, one trending east-northeast toward the Fraser Valley, and the second trending eastward toward Ikadlivik Brook. Esker systems are abundant in the plateau region and most terminate at major eastward-trending valleys (Hare, 1959). Most of these valleys are filled with outwash material that support trees and other vegetation.

The study area (Figure 3) is underlain by gneisses and granites, e.g., paragneiss, felsic to intermediate gneiss, granite, anorthosite, migmatite and amphibolite (Ryan and Lee, 1986; Ryan *et al.*, 1987).

Mineral Aggregates

Mineral aggregates, as used in the context of this report, are defined as any hard, inert material such as gravel, sand, crushed stone, stone or other mineral material that is used in the construction industry (Carter, 1981). These materials can be (a) used in an unprocessed form as pit run, (b) processed and used as Class A and B gravels, and (c) mixed with a cementing agent to form concrete, asphalt, mortar, etc. Road construction is one of the largest consumers of aggregate material.

In order for any development to proceed, aggregate materials are an essential component at some stage; if these materials must be found elsewhere, this will at best lead to increased costs of construction, or at worst act as a limiting factor on developments in the area.

Not all materials are suitable as aggregate. Vanderveer (1983) defines the quality of mineral aggregate by their composition. Aggregates containing too much or too little silt/clay when used in road construction can cause instability, such as flowage in the case of too much fine material, or the loss of compaction properties in the case of too little fine material. Too much fine material in concrete or asphalt can interfere with the bonding process between the aggregate and the cementing agent. The presence of deleterious substances such as a silt/clay coating or iron-oxide staining on the surfaces of the aggregate, and the presence of certain friable or blade-shaped fragments, often cause bonding problems with the cementing agent, or the breakdown of particles with time.

Aggregates are high-volume, low-cost materials. The cost of transport represents, on average, 30 percent of the delivered cost, although long-distance transportation may drive the costs up to 60 percent of the delivered price. With these factors in mind, it would seem most appropriate to construct the road route in an area where quality aggregate material is readily accessible.

SAMPLING AND ANALYTICAL TECHNIQUES

Field Program

Field sampling was conducted by foot, canoe and helicopter traversing. Samples were taken at 1-km intervals or less along most sections of the proposed routes. Where possible, samples were taken from natural exposures such as stream cuts, lake shores and gullied areas. From these exposures, samples were obtained free of plant debris and topsoil. Where natural exposures were not present, samples were taken from hand-dug pits that extended into the soil C horizon, in order to provide a fresh sample unaffected by weathering. Where exposures permitted, channel sampling or multiple-spot sampling was used to ensure a representative sample.

All field and sieve data were placed on two separate forms. Form I gives site information covering data on location, landforms, stratigraphy, ice-movement indicators, and notation for photograph numbers and extra notes. Form II gives a field description of the sample, plus data on field sieve and pebble analyses.

Field sieve analyses were conducted on all samples containing coarse-size material, i.e., greater than 8 mm. Approximately 10 to 20 kg of material were sampled, weighed and sieved through a bank of four sieves of 30 cm diameter (openings of 63 mm, 31.5 mm, 16 mm and 8 mm). The total sample weight and the weights retained on each

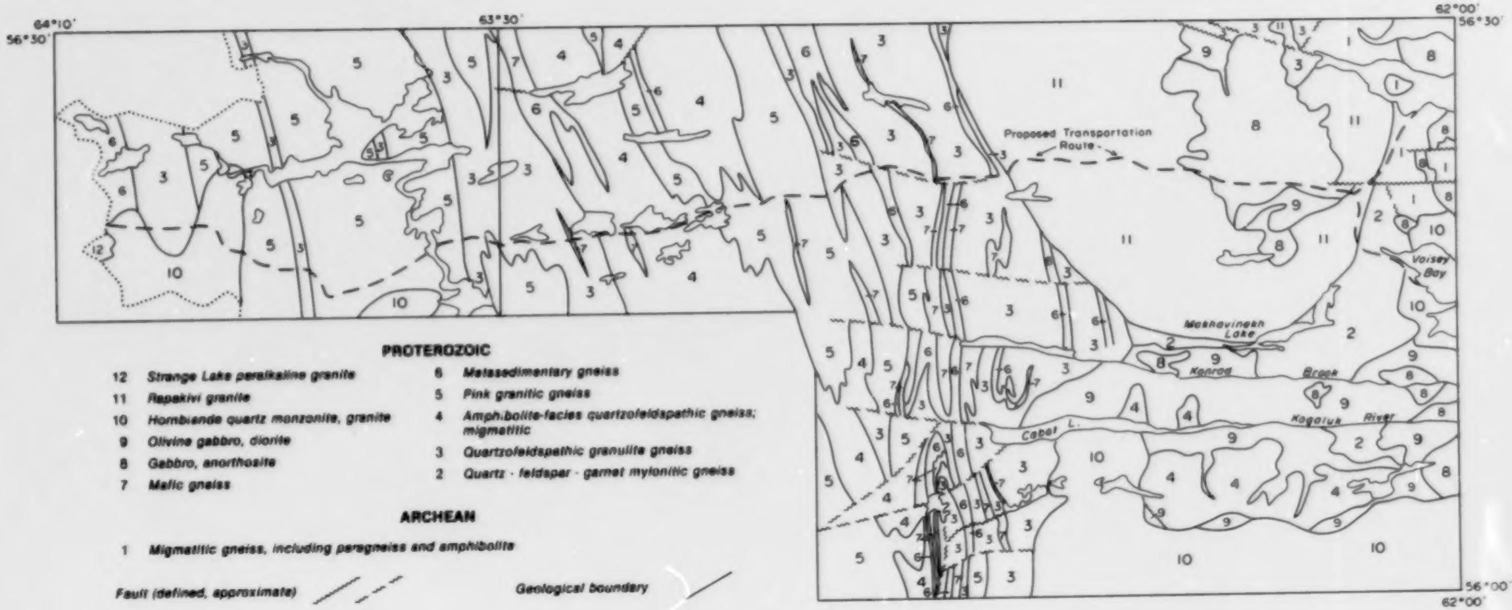

Figure 3. *Generalized geology along the proposed Ikadlivik Brook transportation route (after Ryan and Lee, 1986, and Ryan et al., 1987 – western section, compilation only).*

field sieve and canvas were recorded and a 200 to 500 g split of the sand – silt/clay fraction (finer than 8 mm) was retained for laboratory sieve analyses. A split (100 to 200 pebbles) of the 16 to 31.5 mm pebble fraction of each sieved sample was retained for lithological analyses (Kirby *et al.*, 1983).

Lithological Study

Pebble-lithology studies consist of a review of the geological literature related to the study area, and the determination of the percentage of each rock type found in each sample of pebbles.

The lithological analyses also include information on the silt/clay coating, weathering, staining, sphericity, rounding, fractures, mineralogy and textures for the various rock types present in a given pebble sample.

A petrographic number was calculated for each sample following procedures similar to CSA standard A23.2.30 (Canadian Standards Association, 1973). This petrographic number, ranging between 100 and 1000, is derived by taking the sum of the percentage of each pebble type present, multiplied by a factor (based on soundness and durability) assigned to that rock type. The lower the number is, the better the quality of the aggregate material. See Appendix I for procedures used in petrographic analysis of coarse aggregate.

Laboratory Program

The laboratory program consisted of sieve analyses of the sand – silt/clay fraction (finer than 8 mm) of each sample. The analyses involved drying, splitting and wet and/or dry sieving of each sample as summarized in Appendix II. A split of each bulk (finer than 8 mm) sample was also taken and stored for future analyses and/or reference.

Computer Program

A database management system designed for storage and retrieval of aggregate and surficial-geology data is used to record all field and laboratory data. This system allows for search and retrieval of data on file and the reporting of these data in a format readily understood by potential users (Atkinson, 1984).

DATA PRESENTATION

Samples and Rock Types

Excluding representative rock samples collected to assist lithological analyses, 277 samples were collected for particle-size analyses and lithological investigation. A breakdown of sample types collected are gravel (138), sand (83), sandy gravel (22), till (17), sand/silt (11), silt (4), clay (2) and rock (32). Percentages of gravel, sand and silt/clay, plus petrographic numbers for individual samples are listed in Appendix III. Petrographic numbers obtained from field pebble analyses generally ranged from 150 to 300, indicating hard, durable aggregates suitable for most construction purposes.

Bedrc.k samples collected in the field were used as reference samples for pebble analyses. Rock samples were usually collected along the valley walls and other areas of exposure that were generally away from the proposed route.

Cumulative graphs, showing distribution of grain size material, are available for all granular samples collected in the field. These graphs show percentages of gravel, sand and silt/clay for each sample. Petrographic numbers are also listed on these graphs (Figure 4).

A number of water gaps were also noted along the length of the proposed Ikadlivik valley route. Locations, depths and lengths of these gaps are given in Table 1.

Table 1. Locations, depths and approximate lengths of water gaps along proposed Ikadlivik Brook transportation route

Easting	Northing	Depth	Approx. Length
462000	6240420	4.9 m	110 m
472750	6240880	1.8 m	310 m
479750	6241600	3.7 m	320 m
483620	6241300	0.6 m	20 m
496310	6244620	1.5 m	15 m
496850	6244780	5.5 m	280 m
500350	6244650	2.4 m	20 m
536250	6245700	3.0 m	20 m

Maps

Three sets of maps were compiled for the study area. All mapping was contained within a 6-km-wide corridor, beginning at the Strange Lake deposit on the Quebec – Labrador border and ending in Voisey Bay and Anaktalak Bay. There are two sets of 1:50,000 scale maps consisting of five maps each and one 1:250,000 summary index map.

Surficial mapping, 1:50,000 scale. An integral pert of the program was 1:50,000 scale, reconnaissance-level surficial-geology mapping (Figure 5 and Table 2). Preliminary surficial mapping was compiled from interpretation of 1:50,000 scale black and white airphotos (M. Batterson, personal communication, 1985).

Surficial mapping outlines landforms and/or landform complexes, and special features such as glacial-flow indicators. These data provide a framework for field investigations by outlining areas of potential deposits and thereby narrowing down the area for field traversing and sampling. At the end of the field season, detailed surficial maps were compiled for the 6-km-wide corridor area, which includes parts of NTS map areas 14D/5, 6, 7, 8 and 24A/8.

Landform classification used in surficial mapping is the same as that used by Kirby *et al.* (1983). Each area outlined on a surficial map is assigned a landform system consisting of up to three genetic categories (Table 3), and morphological

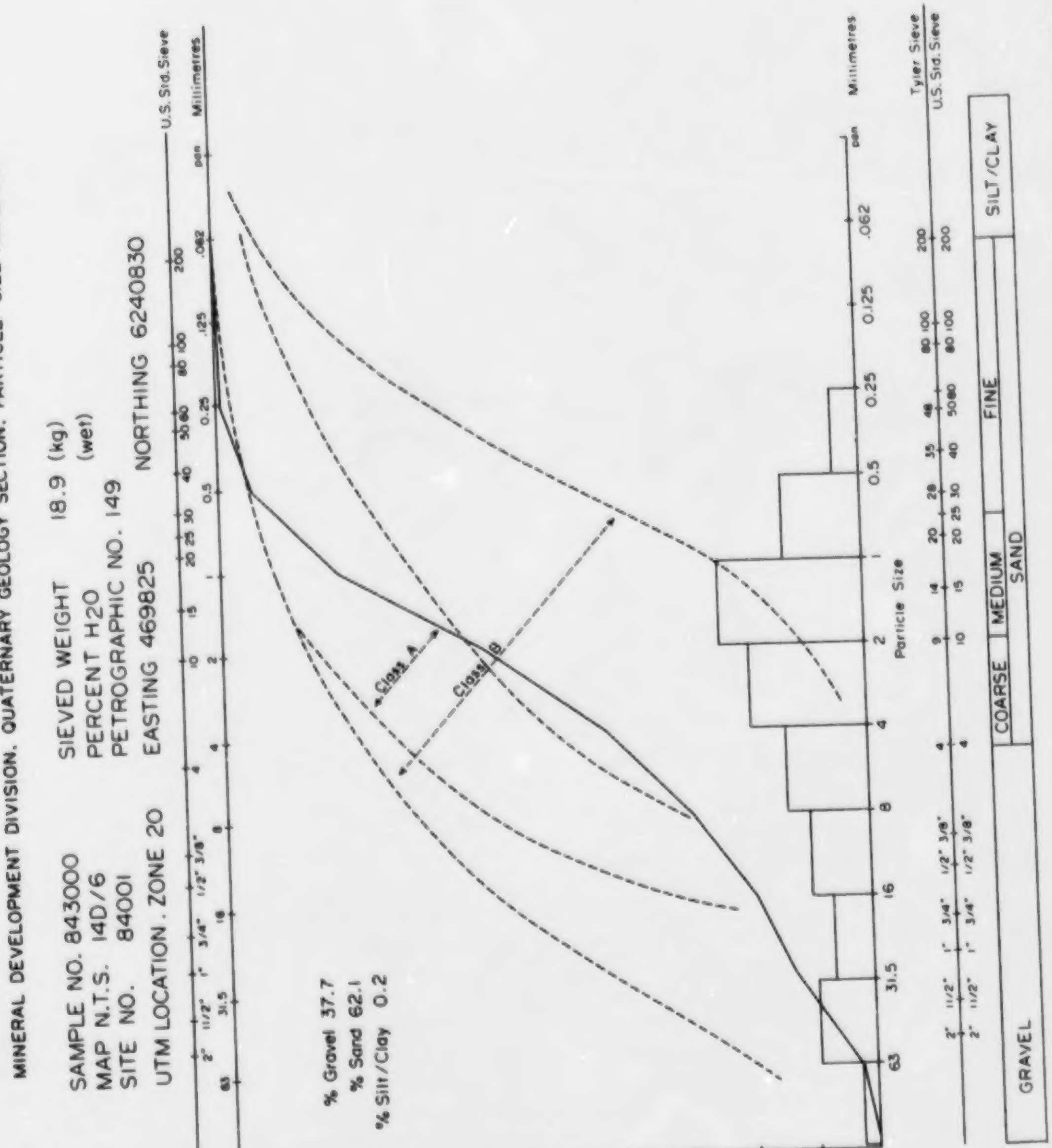

Figure 4. *A typical cumulative graph showing grain-size distribution and comparisons to Class A and B material used in engineering standards; a petrographic number is also given.*

SYMBOLS

Esker (continuous, discontinuous)

Crag and tail hill

Glacial linear feature

Landform boundary

Study corridor boundary

Figure 5. *Specimen portion, 1:50,000 scale landform-classification map, 14D/6 (see Table 2 for landform classification).*

Table 2. Landform classification

Morphological Modifier		Genetic Category								
		Morainal (T)	Glaciofluvial (G)	Alluvial (A)	Marine (M)	Lacustrine (L)	Eolian (E)	Colluvial (C)	Organic (O)	Rock (R)
drumlinoid	(d)	Td								
plain	(p)	Tp	Gp	Ap	Mp	Lp			Op	
hummocky	(g)	Th	Gh				Eh			
ridged	(r)	Tr	Gr		Mr	Lr	Er		Or	Rr
veneer	(v)	Tv	Gv	Av	Mv	Lv	Ev	Cv	Ov	
terraced	(t)		Gt	At	Mt	Lt				Rt
eroded and dissected	(e)	Te	Ge		Me	Le		Ce		
kettled	(k)	Tk	Gk							Rk
deltaic	(f)		Gf	Af				Cf		
lineated	(l)	Tl					El		Ol	Rl
concealed by vegetation	(c)							Cc		Rc
weathered	(w)						Ew			Rw
complex	(x)	Tx	Gx		Mx	Lx				Rx
apron	(a)							Ca		

modifiers (Table 4) that designate the types of deposits within each area. A 1:50,000 scale landform-classification specimen map and legend are shown in Figure 5. Procedures for landform classification are listed in Appendix IV.

Aggregate-resource mapping, 1:50,000 scale. Post-season work focused on production of five 1:50,000 scale aggregate-resource maps. These maps (Ricketts, 1984) are NTS areas 14D/5, 6, 7, 8 and 24A/8. They depict zones of aggregate potential that were initially defined from 1:50,000 scale airphotos and subsequently field checked, sampled and zoned according to aggregate potential. These maps also give sample numbers, localities and type of sample collected in the field. Areas with no zone designations are considered to have no known potential, but this does not completely rule out the possibility that these areas could contain aggregate deposits. It should be noted that the boundaries around designated areas (zones) are arbitrary, as determined from airphotos and field interpretation, and may not represent the true extent of any deposits that may be used as a source of aggregate. A 1:50,000 aggregate-resource specimen map and legend are shown in Figure 6.

Colored aggregate-resource summary map, 1:250,000 scale. The 1:50,000 scale aggregate-resource data have been drafted onto a 1:250,000 scale, multi-colored, summary index map, similar to those by Kirby *et al.* (1983), to accompany this report. This map gives sample type and locality, as well as generalized zones of aggregate potential as summarized from the 1:50,000 scale aggregate-resource maps. Due to high density of sample sites at some localities, not all samples could be transferred to the 1:250,000 summary map. Multiple samples at individual localities are usually indicated by the predominant or most significant aggregate type at that particular site.

PROPOSED ROUTES

Two possible routes originate at the Quebec – Labrador border near the Strange Lake mineral deposit and extend in an easterly direction toward the Labrador coast (Figure 7). One route is toward the Fraser Valley, and the other is along Ikadlivik Brook toward Voisey Bay and Anaktalak Bay.

Table 3. Landform classification: genetic-category definitions

Symbol	Material and process	Origin and characteristics of material
A	Alluvial	Usually less than 1 m thick and confined to material deposited at or near modern-day flood-plain levels; similar to glaciofluvial material in particle size
C	Colluvial	Product of mass wastage or rock falls; massive to moderately stratified, nonsorted to poorly sorted sediments containing usually angular material ranging from clay to boulder size
E	Eolian	Material transported and deposited by wind action; usually medium to fine grained sand and silt, well sorted, poorly compacted, and may be massive or show internal structure such as cross-bedding
G	Glaciofluvial	Material deposited from glacial water and usually lacking in fines; moderately sorted and possibly stratified, normally greater than 1m thick, and located above present-day flood levels; post-glacial fluvial materials have been included in this category
L	Lacustrine	Material having settled from suspension in bodies of standing fresh water; includes stratified and sorted sand, and silt – clay, and/or gravel created from shoreline wave action and deposited above present-day lake levels
M	Marine	Usually clay and silt, although gravel and sand may occur locally; moderately well stratified and sorted, and in some cases contains shells; includes deposits above present-day marine limits (Glaciofluvial- or fluvial-derived sediments deposited in a marine environment are not classified as marine unless they are substantially modified by marine wave action)
T	Morainal	Unsorted and structureless material such as till derived through glaciation; usually contains material with size ranges from boulder to silt/clay
O	Organic	Usually poorly drained accumulations of decomposed peat mosses and other organics
R	Rock	Defined where clearly visible or covered only by a thin soil mat or regolith veneer less than 1m thick; not derived from any of the above processes

Table 4. Landform classification: morphological-modifier definitions

Modifier		Description
a	apron	A sheet of sand or gravel that lies for some distance in front of a terminal moraine or extends out from the banks of a lake or river; also, a series of coalescing colluvial fans at the base of a rock escarpment
c	concealed by vegetation	Indicates lack of appreciable overburden above bedrock or colluvial surfaces
d	drumlinoid	Elongated ridges 3 to 50 m high, 15 to 1000 m long and 5 to 3000 m wide that formed independent of bedrock control in till; the ridges are generally tapered in the down-ice direction and are parallel to the direction of glaciation
e	eroded and dissected	Cut by a series of closely spaced gullies or deeply incised channels
f	deltaic	Fan-shaped deposit having a surface that is either flat or dips away from the apex
h	hummocky	A collection of closely spaced steep-sided hills exhibiting no pronounced orientation, i.e., usually chaotic in plan
k	kettled	Surface depressions formed by melting of ice blocks in glacial sediments (also includes karst depressions in bedrock)
l	lineated	Features raised above the surrounding terrain exhibiting a pronounced parallel or subparallel orientation
p	plain	Deposits greater than 3 m thick, usually areally extensive, that have few definable surface expressions and mask all bedrock features (includes extensive blankets of drift)
r	ridged	Narrow, steep-sided, elongate hills (includes eskers)
t	terraced	Step-like topography, including a scarp face with a usually level surface above it, e.g., marine terrace, kame terrace
v	veneer	Deposits less than 3 m thick that usually reflect features of the underlying topographic rock unit
w	weathered	A veneer, usually less than 1 m thick, of *in situ* decayed rock or sediment
x	complex	Usually indicates numerous esker ridges in close proximity, but may also be used where any genetic category exhibits numerous surface expressions in a small surface area

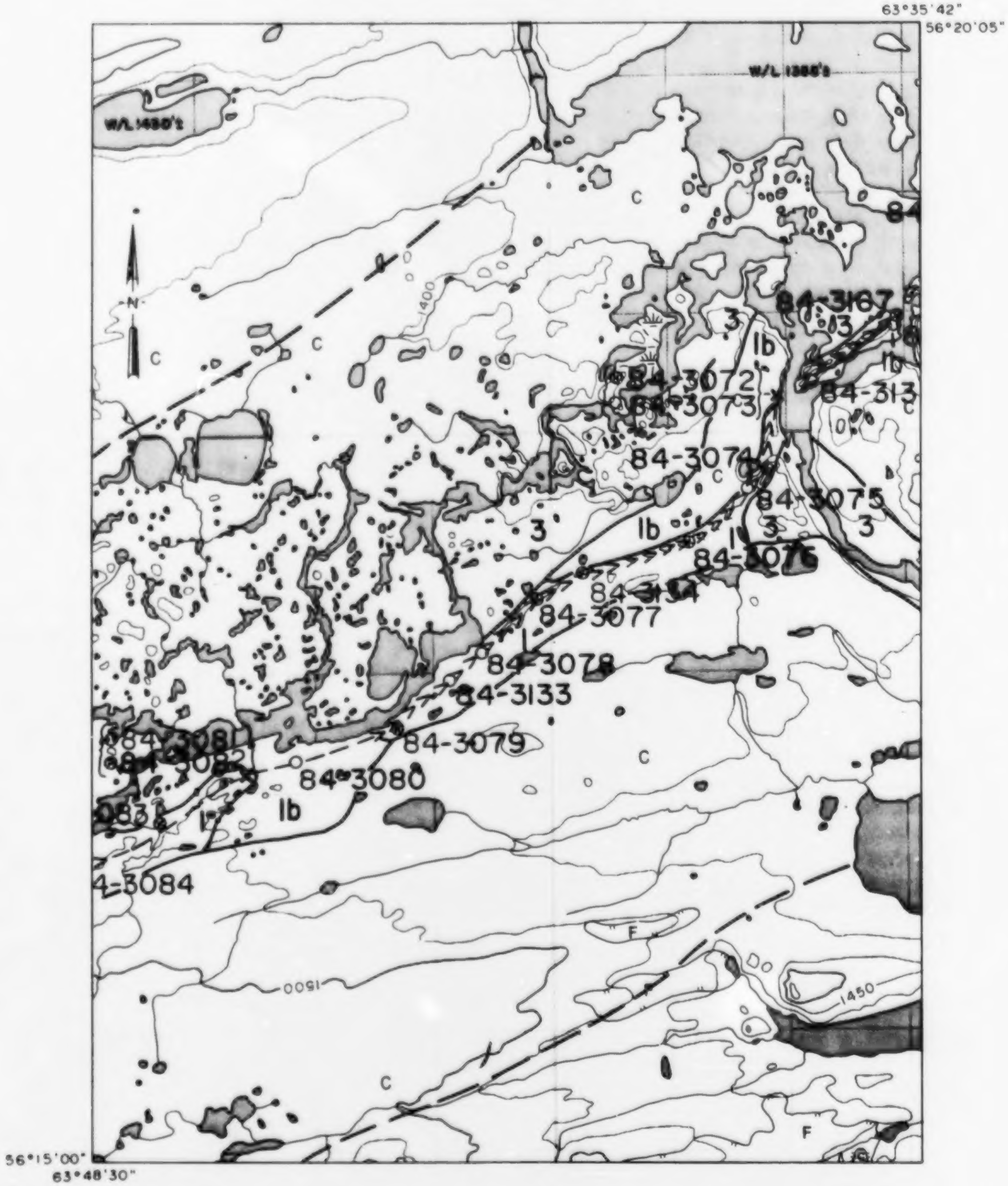

Figure 6. *Specimen portion, 1:50,000 scale aggregate-resource map, 14D/5.*

LEGEND (Specimen)
(Figure 6)

1	*Areas known to contain usable granular materials; probability of locating economic deposits is moderate to high; may include active or inactive pits and quarries*
	Eskers – sinuous ridges of granular materials; moderate to high potential for locating economic deposits
1b	*Areas known to contain granular materials of predominantly sand size; high potential for economic sand exploration, low to moderate potential for other coarser granular-type material*
2	*Areas containing thin or discontinuous, or nearly depleted, usable granular materials; may also include areas where extent of thicker deposits could not be determined by field investigation; probability of locating usable deposits is moderate to low*
3	*Areas that may contain usable granular materials but deposits not substantiated by field investigation; probability of locating usable deposits is low to moderate*
4	*Areas of possible usable materials of nongranular composition, e.g., sandy tills, colluvial or weathered bedrock materials generally containing less than 10 to 15 percent silt/clay that may be beneficiated for higher grade uses*
	Areas having no known potential for location and production of granular materials
	NOTE: *Classification criteria do not include conflicting land uses for routine purposes*
— — —	*Corridor boundary*
●⊗○■ +✱®	*Sample localities (till, gravel, sand, silt, clay, organic and rock respectively)*
⊗84-3079	*Location of gravel sample No. 3079 taken in 1984*
✕{⊗84-3072 ○84-3073	*Location of multiple samples from same site; shown in stratigraphic order*

Fraser Route

The Fraser route follows a continuous sequence of glaciofluvial outwash deposits originating near the Strange Lake deposit. The route is dominated by an east-northeast-trending series of long, sinuous, esker ridges within an esker system that is approximately 70 km long and locally exceeds 20 m in height. This proposed route follows the esker system, with only minor diversions, as far as the Fraser River canyon. No construction problems are expected in the plateau area; however, access down into the Fraser Valley to Tasisuak Lake would present a major problem. The Fraser Valley is a glacial trough and tributaries enter the major valley through hanging valleys. Precipitous cliffs occupy the valley walls for many kilometres (Plate 1). The height difference between the plateau and the valley floor is approximately 500 m. A tributary valley issuing into Tasisuak Lake, located approximately 20 km east of where the glaciofluvial outwash system terminates on the plateau, has slopes gentle enough to allow road construction (Plate 2). However, the 20-km route to this valley traverses an area that lacks quality aggregates, mostly containing a thin layer of silty till (with associated mud boils) and rock outcrop in several places. In addition, a number of gorges would have to be bridged or bypassed, increasing the cost of construction. Even if ore could be

Plate 1. *Precipitous cliffs forming walls of Fraser Valley, 14D/10.*

transferred from the plateau to the valley floor, other problems exist to hinder access to the coast. The outlet of Tasisuak Lake is obstructed by cross-valley moraines (Plate 3) and associated shoreline features. Ocean-going vessels can navigate most of Tasisuak Lake, but the river mouth would

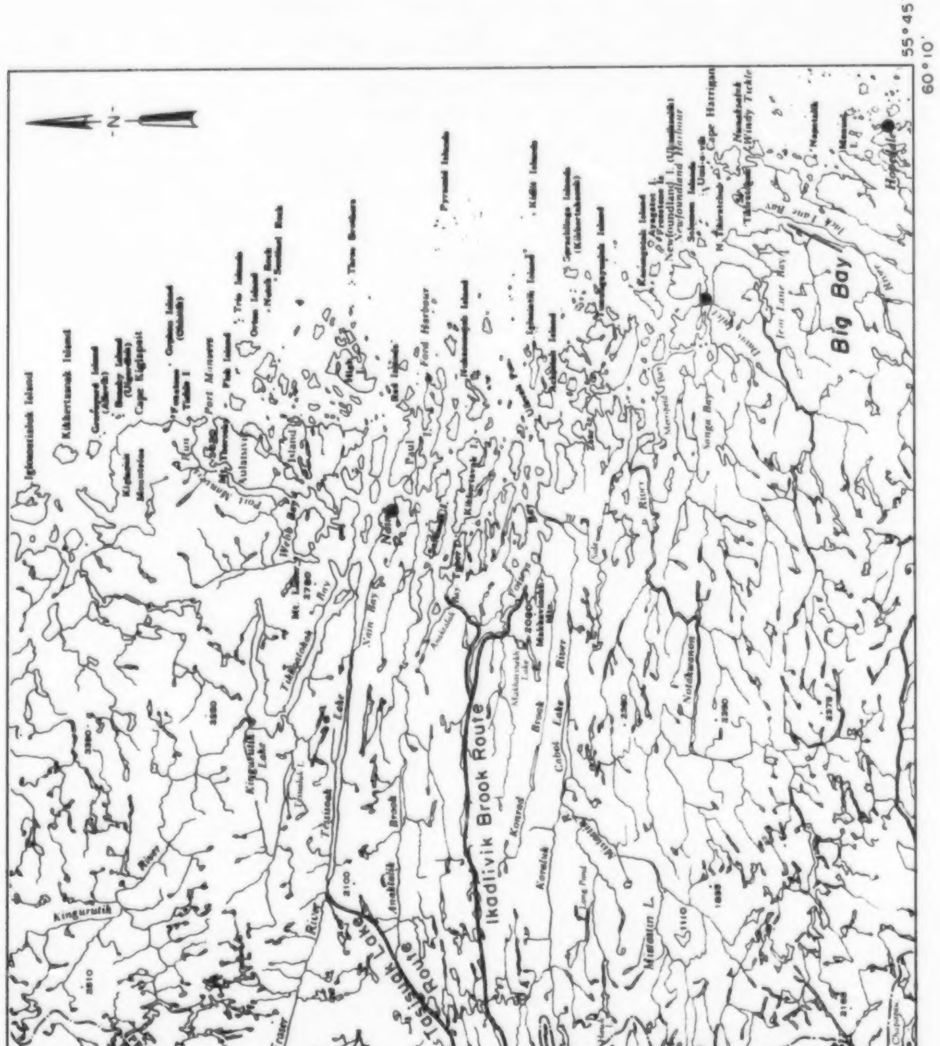

Figure 7. Proposed transportation routes from Strange Lake to Atlantic coast.

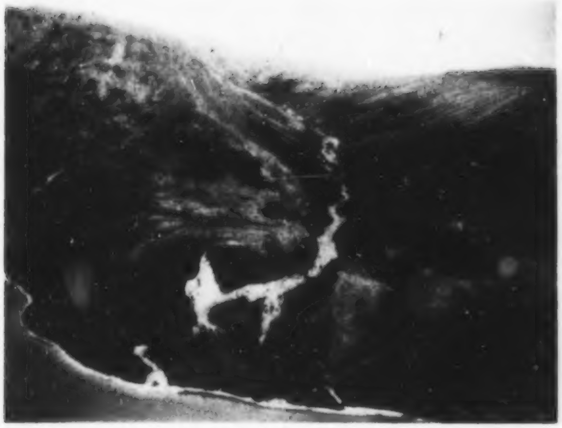

Plate 2. *Tributary valley leading into Fraser Valley, 14D/10.*

Plate 3. *Cross-valley moraines at the eastern end of Tasisuak Lake, 14D/9.*

have to be dredged or a series of locks constructed to provide an outlet to the ocean. Further, the Fraser River Valley in general and Tasisuak Lake in particular is an arctic char migration area. It is therefore doubtful that any development would be permitted in the lake area. As a result, the Fraser route is less likely to be usable and therefore was not studied in detail.

Ikadlivik Brook Route

The Ikadlivik Brook route was studied in greater detail. This route is approximately 148 km long and follows a glaciofluvial outwash system of considerable resource potential from the Strange Lake deposit to Anaktalak Bay on the Labrador coast. Comparisons of aggregate deposits along this route are outlined in Table 5. Grain-size percentages and petrographic numbers given in Table 5 are averages taken from individual sample data listed in Appendix III. Samples containing high silt/clay percentages, in deposits consisting of predominantly high sand and gravel concentrations, were omitted from the averaging process to avoid distorting the typical grain-size distribution in aggregate deposits along the proposed Ikadlivik Brook route.

The Ikadlivik Brook route follows the Fraser route for 9 km east of the Strange Lake deposit, then turns southward, following the banks of two river channels for another 16 km to the next major eastward-trending valley. The first 9 km of the route (following the Fraser route) follows the top of a dissected esker composed of cobble – pebble gravel; scattered boulders occur along parts of the ridge. A deposit of medium to fine grained sand is located in the area where the proposed Ikadlivik Brook route turns southward away from the Fraser route. Material along the river channels consists of fine grained sandy till, and a 2-km stretch of bogland (Plate 4) separates the two channels. The bogland appears to be shallow, contains scattered protruding boulders, and should not cause any major problem in construction. A more detailed study is needed to determine the effects of permafrost on road construction in this area.

Plate 4. *Bogland, containing numerous boulder protrusions in foreground, between proposed Fraser Valley transportation route and Ikadlivik Brook valley route, 14D/5.*

The route along the river channels joins a major esker system (Plate 5), which extends in an easterly direction across half of map area 14D/5 and all of 14D/6, covering a distance of 53 km. The esker reaches heights of up to 20 m (Plate 6) and is discontinuous. It is interrupted by gaps of variable size, being dissected by either meltwater channels or channels connecting small lakes. Other gaps develop where the eskers terminate in lakes or where the eskers were not deposited. In those places where intervening waters are shallow, culverts and cut-and-fill operations could be employed. However, there are some places where currents are strong and a bridge or large culvert would have to be installed.

TABLE 5. Summary and comparison of aggregate deposits along tne proposed Ikadlivik Brook valley route

Area	Length km	Total number of samples collected	Samples collected for petrograhic analyses	Petrographic numbers		% Gravel (+ 5mm)	% Sand (+ 0.074 mm to − 2mm)	% Silt/Clay (−0.74 mm)
				Average	Range			
From Strange Lake mineral deposit eastward for 9 km on the Fraser route (24A/8 and 14D/5)	9.5	11	10	255.5	155-398	50.7	49.72	0.3
Two river channels between the Fraser esker route and the Ikadlivik Brook route (14D/5)	16	7	5	236	162-328	31.87	53.92	14.24
Esker system (14D/5 and 14D/6)	53	90	64	217	117-411	46.97	51.83	0.86
Esker to Ikadlivik Brook valley (14D/7)	9	6	6	185	155-249	50.44	42.22	7.32
Ikadlivik Brook valley (14D/8 and (14D/9)	46	104	65	175	111-268	48.05	50.03	2.10
Esker along upper part of Ikadlivik Brook valley (eastern end of map area 14D/8)	7	16	9	137.7	127-195	45.79	53.02	1.18
From the junction of Reid Brook and Ikadlivik valleys to Voisey Bay (14D/8)	13	19	1	125	125	4.65	81.87	13.42
Through Reid Brook valley to Anaktalak Bay (14D/8)	14.5	25	5	235	205-318	16.73	56.31	26.94

Note: Petrographic analyses were conducted on all samples with greater then 16 mm size material. Percentages of gravel, sand and silt/clay are based on total numbers of all granular samples collected. These percentages do not take into account exposure heights at different site localities.

Plate 5. *Esker ridge and outwash sands stretching eastward toward Ikadlivik Brook valley, 14D/6.*

Plate 7. *Gravel in dissected esker 14D/6.*

Plate 6. *Fifteen- to twenty-metre-high esker ridge, 14D/6.*

Plate 8. *Sand-plain, with esker ridge to left side of photo, 14D/5.*

Aggregate samples taken along the esker system show a dominant gravel texture (Plate 7), although boulder and sandy materials were sampled in several places. Some of the gravels are massive in texture while others are sorted and stratified. There are places along the route where the esker divides into two or more parallel ridges and may continue over a kilometre before rejoining. Depressions between these ridges contain kettle holes. Other places along the esker are occupied by mazes of interlocking ridges known as esker complexes, which occur in two or three localities along the esker system. Esker knobs, or areas that are higher (up to 3 m) than the ridge and generally contain coarser material of small semirounded boulders at the top, also occur. Sand-plains (Plate 8) were also located along the route. Sand-plains are generally restricted to areas in close proximitiy to eskers and most are considered to be genetically associated with the esker deposit. They are usually found in areas where the esker ridge dwindles in size and merges into the surrounding land. Sand-plains vary in size from a few hundred metres to 3 km across (Henderson, 1959). The most noteable sand-plain in the study area is situated near the southeast corner of map area 14D/5, having an approximate length of 2 km and a width of 1 km.

The esker system tapers off at the western margin of map area 14D/7. A 6-km stretch of boulder till, fine grained sandy till and rock outcrops occurs between here and the Ikadlivik Brook valley. There are scattered mud boils and small patches of bogland along this section. The slope of the land is steep enough to allow adequate drainage by ditching if road construction occurs in the area.

The Ikadlivik Brook valley, along the eastern half of the proposed transportation route, is approximately 55 km long. It has a well developed valley floor and sidewalls rising up

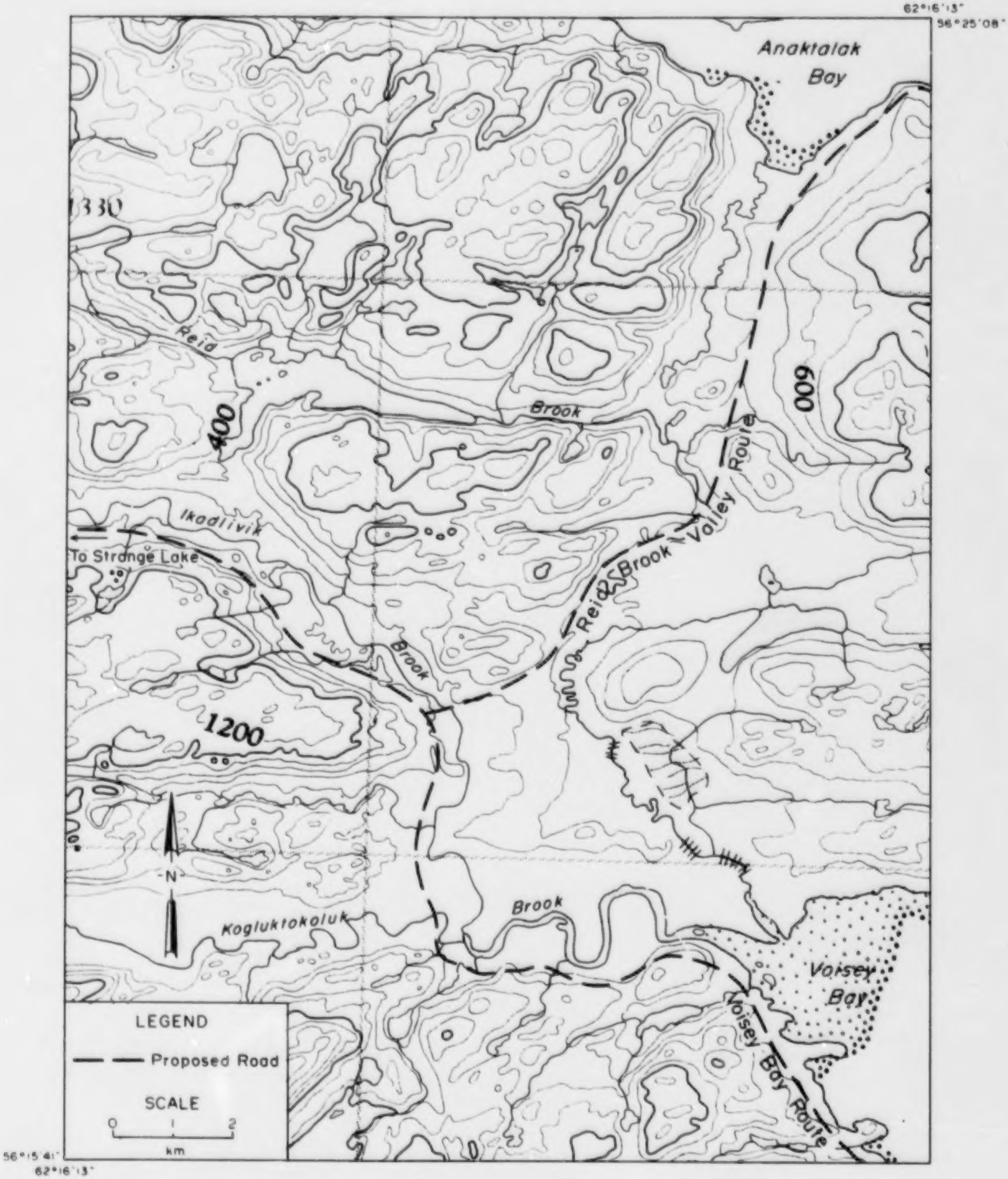

Figure 8. *Access routes from Ikadlivik Brook valley route to Atlantic coast.*

Plate 9. *Outwash deposits in Ikadlivik Brook valley.*

Plate 10. *Eroded slopes in area of sand, silt and clay, 14D/8.*

to 140 m. Abundant glaciofluvial outwash deposits are evident in the valley (Plate 9). These are largely kame depoists, associated kettleholes and some eskers. There is an abundance of good quality aggregate, although large deposits of sand, some silt and clay cover much of the lower part of the valley. Blasting of rock may be required at a few narrow sections along the valley. There are many rapids and shallow areas in the upper part of the Ikadlivik Brook, whereas the lower half is deeper and has fewer rapids. The river section may have to be crossed in 2 or 3 localities. These crossings are narrow and should not pose any difficulty in bridge construction.

Two access routes (Figure 8) leading from Ikadlivik Brook to the ocean were studied. One route extends past the confluence of Ikadlivik Brook with Kogluktokoluk Brook, and leads into Voisey Bay. The second route leads northward and exits Ikadlivik Brook via the Reid Brook valley, and terminates at Anaktalak Bay.

The Voisey Bay access route is approximately 0.5 km shorter than the Anaktalak Bay route, and extends over an area containing granular material of predominantly sand size, which overlies deposits of silt and clay. The stability of this route would have to be assessed for road construction. Large deposits of sand, silt and clay (Plate 10) are present along most of this route. In addition, steep rock faces are an impediment in places, and water depth at the landward end of Voisey Bay may not be sufficient for ocean-going vessels. There are extensive shallows at the mouth of Ikadlivik Brook, although an adequate channel appears evident on the north side of the bay opposite Garland Bight (Batterson and Vanderveer, 1984).

The alternative route, northward through the Reid Brook valley, flows into Anaktalak Bay. This route, although slightly longer, appears to be the best route to the coast. The Reid Brook valley has deposits of coarse granular materials at key positions along the route, although deposits of sand, silt and clay were also sampled. Reid Brook flows into a deeper bay with only minor shallow areas along the shoreline, allowing access for large ocean-going vessels. Both routes will require installation of culverts or bridges to cross the numerous streams entering the main river system.

Conclusion

A suitable transportation route could be constructed from the Strange Lake deposit following a glaciofluvial outwash system in an east – northeast direction to the Fraser River Valley. However, apparently insurmountable problems are encountered on reaching the Fraser River Valley, such as the nearly 500-m vertical drop at the entrance to the valley, an arctic char migration route in the Fraser River, and shallow areas near the mouth of the river that would require dredging or lock construction to provide access for ocean-going vessels. Therefore, this route is considered unsatisfactory.

The Ikadlivik Brook valley route is the most suitable one to the Atlantic coast. Along the plateau section, large aggregate deposits and the well developed esker ridge should provide a suitable route and adequate construction materials, although several streams must be traversed. In the Ikadlivik Brook valley, access to the ocean can be achieved by a route northward through the Reid Brook valley or southward into Voisey Bay. The Reid Brook route into Anaktalak Bay appears to be the better choice because of a deeper bay and the availability of deposits of coarser granular material.

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APPENDIX I

Procedure for the petrographic analysis of coarse aggregate [revised from CSA-A23.2.30 (Bragg, 1986)]

1. Scope

1.1 This Standard covers the procedure for the petrographic analysis of coarse aggregate samples. It is a method of appraising the quality of coarse aggregate and provides a numerical method of expressing and comparing the qualities of different samples.

2. Apparatus

2.1 The apparatus shall consist of the following:

(a) A hand lens of 10X magnification
(b) An alnice magnet
(c) A pocket knife with a blade hardness between 5.5 and 6.0 on Mohs scale
(d) A hammer and anvil suitable for breaking aggregate particles
(e) A 5 percent solution of technical grade hydrochloric acid, 20° Bé
(f) A 400-millilitre polyethylene squeeze bottle with spout

3. Test Sample

3.1 A representative sample of pebbles between 16 mm and 32.5 mm are collected (usually around 100 pebbles).

4. Test Procedure

4.1 The sample shall be spread out on a flat working surface.

4.2 The aggregate shall be examined for coatings (such as clay), cementations and encrustations which may affect the bond with cement paste.

4.3 If clay balls or other particles which may break down in water or with normal handling are present, they shall be separated out at this stage of test.

4.4 The sample shall be examined visually for shape characteristics and the estimated percentage of crushed, flat or elongated particles noted.

4.5 On completion of the steps outlined in Clauses 4.1 through 4.4 the sample (exclusive of clay balls, etc.) shall be washed to remove any clay or dust coatings.

4.6 Each particle in the sample shall be identified by visual examination and sorted into the rock types listed in Table 1, Appendix I.

4.7 In the identification procedure, the following points shall be noted:
(a) Particle shape
(b) Particle surface
(c) Grain size
(d) Texture
(e) Color
(f) Mineral composition
(g) Significant heterogeneities (e.g., fossils, shale or clay partings, cementation)
(h) Chemical properties (e.g., backing, iron compounds)
(i) Physical properties (e.g., hardness, fracture, porosity)
(j) Physical condition (e.g., weathered, fractured)

5. Calculations

5.1 The percentage of each rock type shall be calculated to the nearest 0.1 percent.

5.2 The petrographic number (PN) shall be calculated as the sum of the products of the percentage of each rock type multiplied by the appropriate factor given in Table 1 and Table 2, Appendix I.

NOTE: The scratch and acid tests will, with visual examination, usually be sufficient to classify most rock types, however, any rock types which may contain deleterious material should be examined microscopically.

Table 1 (Appendix I). Petrographic factors for pebbles of various compositions

Lithology	Petrographic Factor Range	Usual Factor
1. Sandstone	(1-6)	(3)
2. Shale	(10)	(10)
3. Mudstone	(3-6)	(6)
4. Siltstone	(1-6)	(3)
5. Conglomerate	(1-10)	(6)
6. Arkose	(1-6)	(1)
7. Argillite	(3-6)	(6)
8. Graywacke	(1-6)	(1)
9. Chert	(1-3)	(1)
10. Limestone	(1-6)	(1)
11. Dolomite	(1-6)	(1)
12. Quartzite	(1-6)	(1)
13. Granite	(1-6)	(1)
14. Gabbro	(1-6)	(1)
15. Diorite	(1-6)	(1)
16. Granite–diorite series	(1-6)	(1)
17. Felsic volcanics	(1-6)	(1)
18. Mafic volcanics	(1-6)	(1)
19. Intermediate volcanics	(1-6)	(1)
20. Felsic–mafic volcanics	(1-6)	(1)
21. Pyroclastics	(3-6)	(3)
22. Metavolcanics	(3-6)	(3)
23. Gneiss	(1-6)	(3)
24. Schist	(3-10)	(6)
25. Phyllite	(6-10)	(6)
26. Marble	(1-6)	(1)
27. Slate	(10)	(10)
28. Amphibolite	(6-10)	(6)
29. Ultramafic	(6-10)	(6)
30. Metasediments	(1-6)	(3)
31. Iron formation	(6-10)	(10)
32. Drift deposits	Any or all of the above	Any or all of the above

Table 2 (Appendix I). Petrographic legend

Petrographic Factor		Weathering Gradation		Final Petrogrpahic Factors (Variations based on rock type)
Number	Classification	Number	Classification	
1	Good	1	Fresh	1
		2	Slightly weathered	1, 2
		3	Moderately weathered	3, 4
		4	Highly weathered	5, 6, 7
		5	Intensely weathered	8, 9, 10
		6	Residual soil	10
3	Fair	1	Fresh	3
		2	Slightly weathered	4, 5
		3	Moderately weathered	6, 7, 8
		4	Highly weathered	8, 9
		5	Intensely weathered	10
		6	Residual soil	10
6	Deleterious	1	Fresh	6, 7
		2	Slightly weathered	8, 9, 10

APPENDIX II

Test for sieve analysis of fine aggregate (revised from CSA-A23.2.2)

1. Scope

1.1 This Standard covers a procedure for the determination of the particle size distribution of fine aggregate, using sieves with square openings.

2. Apparatus

2.1 The apparatus shall consist of the following:

(a) Balance. The balance or scale shall be sensitive to within 0.1 percent of the weight of the sample to be tested;
(b) Sieves. The sieves shall have square openings and shall be mounted on substantial frames constructed in a manner that will prevent loss of material during sieving. Suitable sieve sizes shall be selected to furnish the information required by the specifications covering the materials to be tested. The woven wire cloth sieve shall conform to ASTM Standard E11, Wire-Cloth Sieves for Testing Purposes; and
(c) Oven. An oven of appropriate size, capable of maintaining a uniform temperature of 120 ± 5C.

3. Samples

3.1 Samples for sieve analysis shall be obtained from the materials to be tested by the use of a sample splitter or by a suitable method of quartering. Fine aggregate sampled by the quartering method shall be thoroughly mixed. The sample for test shall be approximately of the weight desired and shall be the end result of the sampling method. The selection of samples of an exact predetermined weight shall not be attempted.

3.2 Samples of fine aggregate for sieve analysis shall weigh, after drying, approximately 70 to 140 g. In no case, however, shall the fraction retained to any sieve at the completion of the sieving operation weigh more than 4 grams per square inch (0.60 gm/cm) of sieving surface.

NOTE: This amounts to 140 grams for the usual 8-inch (200-mm) diameter sieve. The amount of material retained on the critical sieve may be regulated by the
(a) Introduction of a sieve having larger openings than in the critical sieve; or
(b) Proper selection of the size of the sample.

4. Preparation of Sample

4.1 Samples shall be dried in an oven at a temperature of 120 ± 5C.

5. Procedure

5.1 For each sample of gravel or sand (i.e., samples which appear to contain less than 2 percent silt and/or clay material):

(a) Place sample in bank of seven sieves with screens sizes of 4 mm, 2 mm, 1 mm, 0.5 mm, 0.125 mm and 0.062 mm.
(b) This bank of sieves is placed on automatic shakers for 10-12 minutes.
(c) The material retained in each sieve is weighed on a balance as specified in clause 2.1(a).

5.2 Tills and other samples which contained a high silt and/or clay content were treated as follows:

(a) The sample was deflocculated using a sufficient amount of hydrogen peroxide solution (3 percent H_2O_2), to wet the sample.
(b) The sample was wet sieved through the 0.062 mm sieve and the water and silt clay material which passed through the 0.062 mm sieve was collected in a 8-litre plastic bucket.
(c) The plus 0.062 mm sand fraction, retained on the 0.062 mm sieve, was dried and sieved as per the procedures in 5.1(a), 5.1(b) and 5.1(c).
(d) The minus 0.062 mm fraction (water and silt and clay) was flocculated by adding a small amount of magnesium chloride (IN $MgCl_2$). After a 24-hour period, the excess water was siphoned off and the resultant silt-clay was dried and weighed.

6. Reporting

6.1 The results of the sieve analysis are recorded on a laboratory sieve analysis form.

APPENDIX III

Grain-size analyses, petrographic numbers, and deposit length, width and thickness

(See microfiche in pocket attached to inside of back cover.)

APPENDIX IV

Procedures for landform classification

(after Kirby *et al.*, 1983)

Surficial mapping outlines landforms and/or landform complexes, and special features such as glacial-flow indicators. Each category within a landform system is listed in the order of prominence of its occurrence in the defined area, and is separated from the other categories by a slash, e.g., Tv/R. In this case, T and R are the genetic categories and v is the morphological modifier. The areas have been divided so that normally a maximum of three landforms are identified within a given area. Six variations of landform systems are possible. The landform-classification system is also used to denote the approximate percentage of landforms occurring within an outlined area.

1) A single slash (/) is used to separate the different landforms. The slash can normally be used to separate up to three landforms, e.g., Tv (60-85 percent)/R (15-40 percent) or Tv (45-80 percent)/Th (15-40 percent/R (5-15 percent).

2) A double slash (//) is normally used to separate two different landforms, e.g., Tv (85-95 percent)//R (5-15 percent).

3) Stratigraphy or superposition of a preceding genetic landform over the following landform is represented as follows, e.g., $\frac{Ov}{T}$ This indicates that 95-100 percent of the area is an organic veneer over till.

4) Transition zones between two landform types where both have approximately the same percentage are denoted by a dash, e.g., Te (35-40 percent) – Tl (35-40 percent)/ R (15-20 percent).

5) Stratigraphy wherein more than one landform type overlays another landform type, e.g., $\frac{Ov/G}{T}$ This indicates that approximately 60-80 percent of the area is covered by Ov and 15-40 percent is covered by G and the area is completely underlain by till.

6) Stratigraphy indicating that only one unit overlays some of the other units, e.g., Tv/ $\frac{Ov}{T}$ indicates that 60-85 percent of the surface area is covered by a veneer of till (Tv)and that the remainder of the area (15-40 percent) consists of organics over till.

It should be noted that you may get different combinations and variations of the above landform combinations, e.g., Te-Tl/ $\frac{O}{R}$ indicating that 15-20 percent of the area is covered by organics which are underlain by rock and the remainder (80-85 percent) is made up of approximately equal amounts of Te and Tl.

MAPS NOT FILMED

CARTES NON REPRODUITES